United States Patent

[11] 3,626,235

[72] Inventor George A. Kupsky
Milford, N.J.

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[73] Assignee Burroughs Corporation
Detroit, Mich.

[54] DISPLAY PANEL WITH DOUBLE CATHODE

4 Claims, 5 Drawing Figs.

[52] U.S. Cl. ..... 313/210, 313/217, 315/169, 315/169 TV

[51] Int. Cl. H01j 61/66

[50] Field of Search ..... 313/108 B, 188, 195, 196, 201, 210, 217, 301, 109.5; 315/169 TV, 84.6, 169

[56] References Cited

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Primary Examiner—Roy Lake
Assistant Examiner—Siegfried H. Grimm
Attorneys—Kenneth L. Miller and Charles S. Hall

ABSTRACT: A display panel including first and second layers of gas-filled cells with cathodes in common between the layers and with separate anodes associated with each layer. Tiny apertures in the cathodes interconnect respective cells in each layer. Double-layered cathodes are used to prevent spurious transfer of ionized gas (cathode glow) from the cells in one layer to the respective cells in the other layer.

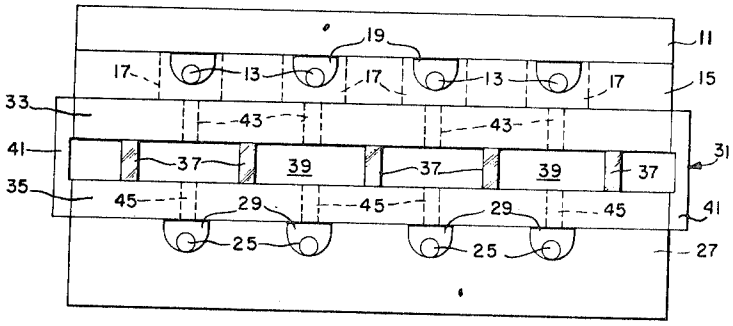
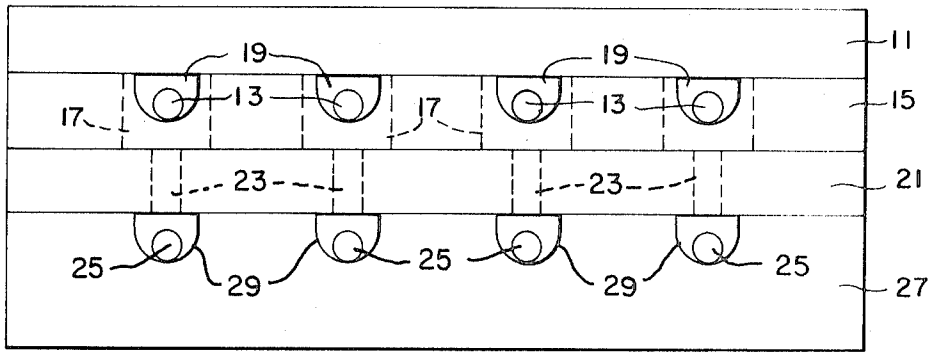


FIG. 1.
(PRIOR ART)



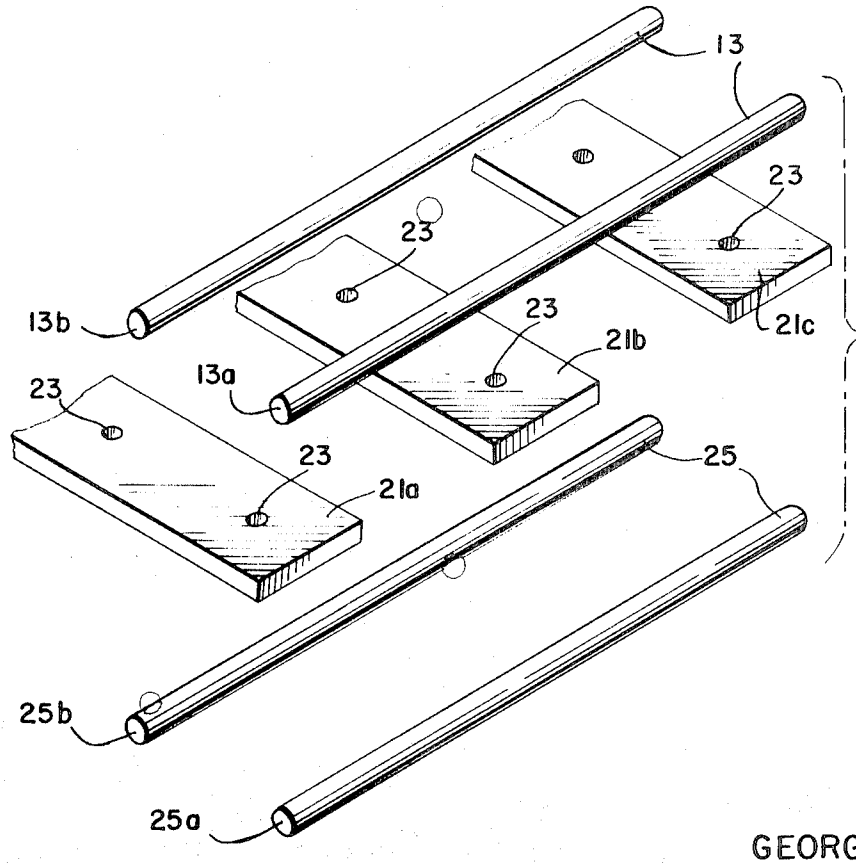


FIG. 3.
(PRIOR ART)

INVENTOR
GEORGE A. KUPSKY

BY Jerold L. Schneider

AGENT

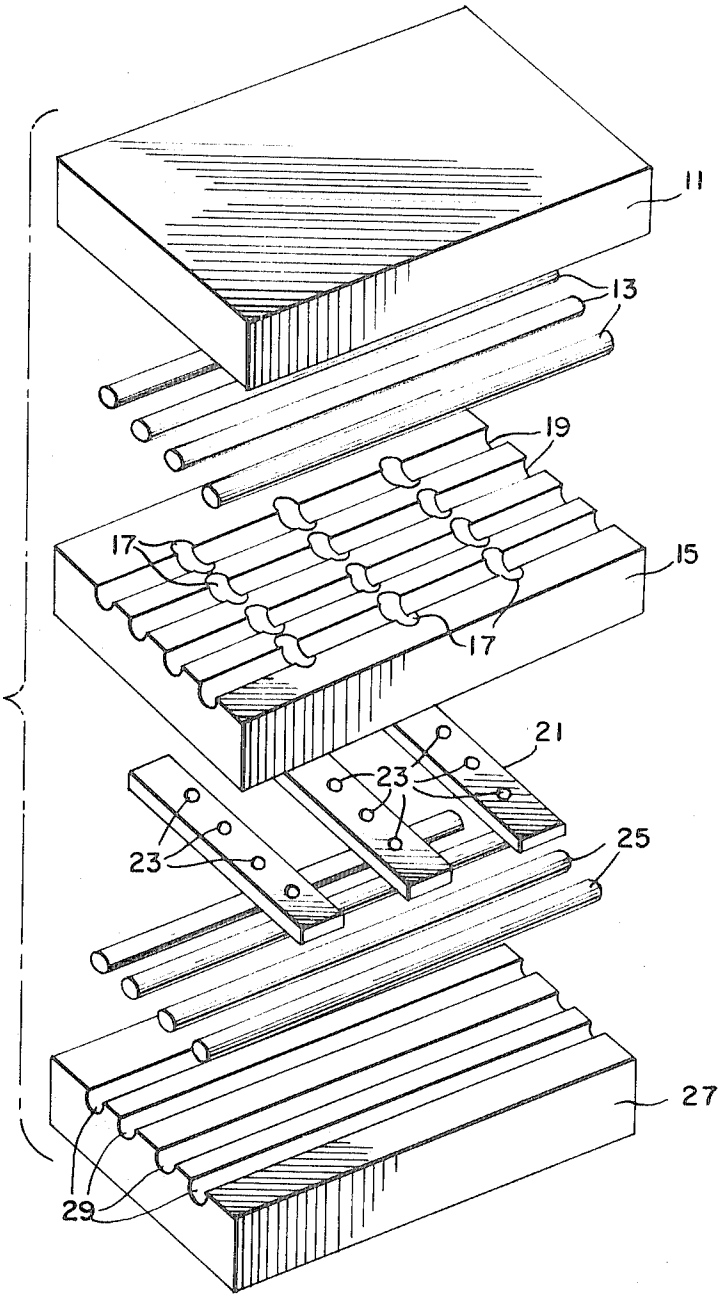


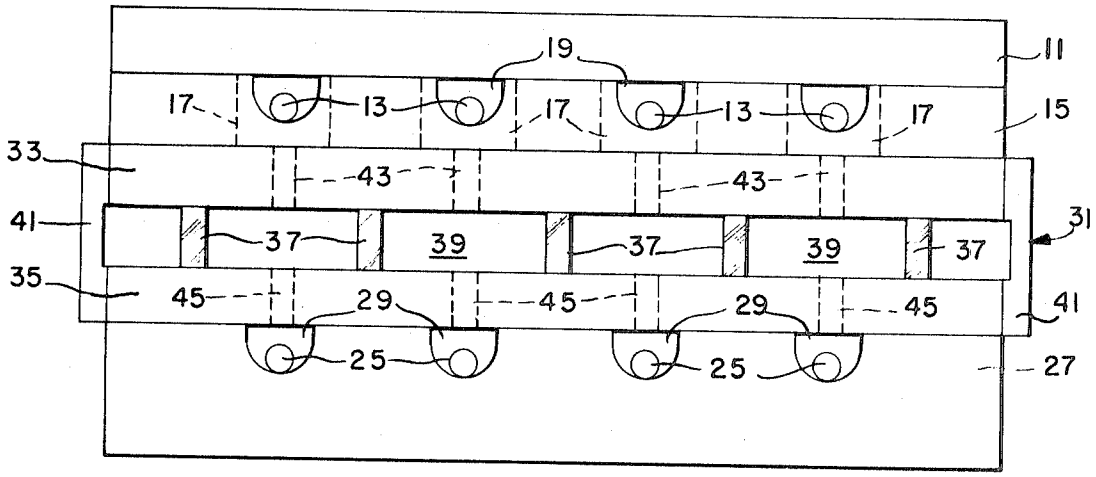
FIG. 2.
(PRIOR ART)

INVENTOR
GEORGE A. KUPSKY

BY Jerold J. Schneider

AGENT

FIG. 4.



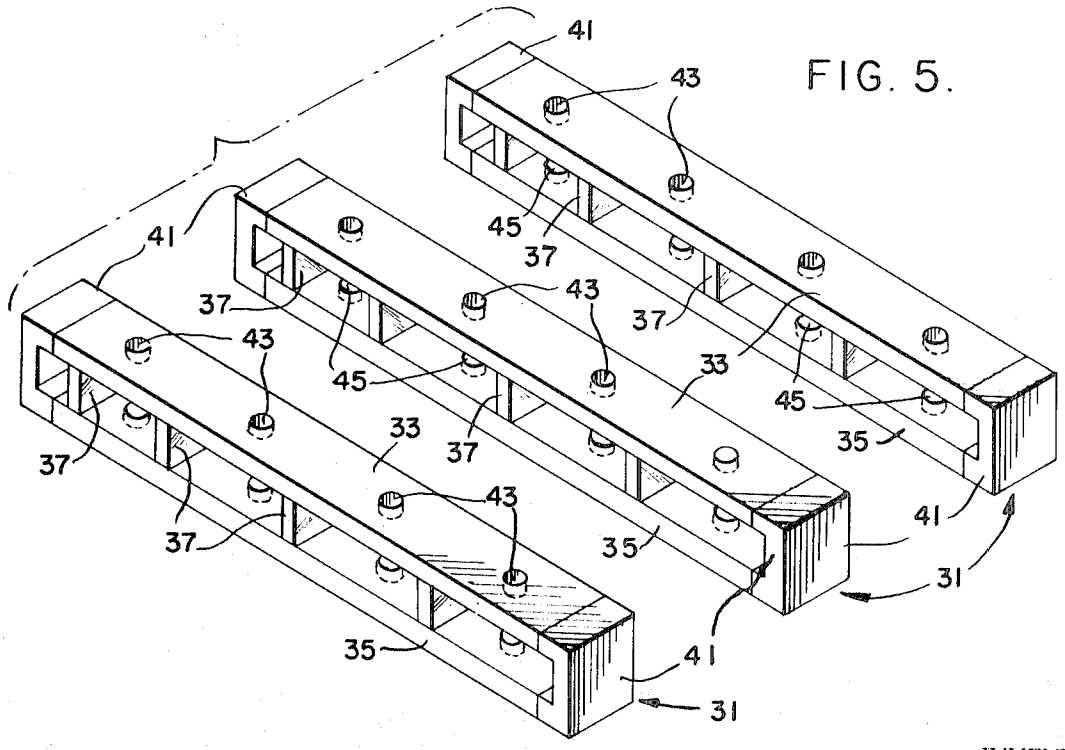


FIG. 5.

INVENTOR
GEORGE A. KUPSKY

BY Jerold I. Schneider

AGENT

DISPLAY PANEL WITH DOUBLE CATHODE

BACKGROUND OF THE INVENTION

Display panels comprising a plurality of gas-filled cells which can be turned on selectively to display a message are known in the art, but have thus far not become widely used commercial devices. In a recent development, a display panel has been invented having upper and lower layers of cells and utilizing cathodes in common between the layers. The cathodes are usually in the form of parallel metal strips each having across its length a row of tiny apertures interconnecting the gas cells in the upper or display and the lower or scanning layers thus forming an array of such apertures. The lower layer of cells is continuously scanned to maintain cathode glow on the lower surface of the cathodes around the apertures. As information signals are applied to the anodes of the upper layer of cells, synchronously with the scanning, the cathode glow spreads to the front surface of the cathode at the selected upper cell or cells to form a visible unit of display.

In the prior art, the maintained glow on the lower surface of the cathodes tended to be spuriously or inadvertently transferred to individual ones of the upper display cells, possibly causing an aberration in the message being displayed. Such inadvertent transfer of cathode glow could be caused by certain conditions of current density in the scanning operation or by minor variations in the diameter of the tiny apertures interconnecting the aligned pairs of upper and lower cells.

SUMMARY OF THE INVENTION

Accordingly it is the object of this invention to provide a new and improved cathode structure in a double layer gas cell display panel to prevent inadvertent transfer of the cathode glow from the scanning cells into the display cells.

This and other objects and advantages of the present invention are accomplished in a display panel including upper and lower layers of communicating gas-filled cells, with separate anodes associated with the upper and lower layers of the cells, by utilizing a double cathode in common between the layers. The double-cathode provides an intermediate layer of cells which retains cathode glow if the glow should spuriously transfer from a cell in the lower layer of cells toward an upper display cell.

DESCRIPTION OF THE DRAWINGS

The object and advantages of this invention will be more fully understood upon reading the following description in connection with the drawings. In the drawings, wherein like numerals designate corresponding elements:

FIG. 1 is an end view of a prior art display panel;

FIG. 2 is an exploded perspective view of the panel of FIG. 1;

FIG. 3 is a partial view of the panel of FIG. 2;

FIG. 4 is an end view of a display panel including the cathode of this invention; and

FIG. 5 is a perspective view of the double cathode of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The display panel described herein is a thin, flat, sheetlike sandwich which may have substantially any desired size and shape from, for example, postage stamp size to wall size, and it may include an array of substantially any number of cells. The panel may also include any suitable ionizable gas such as neon, argon, etc., singly or in combination with a vapor of a metal, such as mercury, which is usually included in the gas to minimize cathode sputtering.

Referring to FIGS. 1 and 2 a prior art display panel includes an upper viewing plate 11 of an hermetic dielectric material such as glass or ceramic. Located below the upper plate are first parallel electrodes 13 which are operated as display anodes in the preferred mode of operation of the panel. Located below the display or upper anodes 13 is an insulating

plate 15 of an hermetic dielectric material such as glass or ceramic. Insulating plate 15 has a matrix of holes 17 therethrough and in the upper surface of insulating plate 15 there is a plurality of grooves or slots 19. For purposes of this description the upper anodes 13 and the grooves 19 are to be considered oriented horizontally. Upper anodes 13, which are preferably in the form of wires, are seated in the grooves 19 when the panel is assembled. The anodes 13 might, alternatively, be seated in grooves (not shown) in the bottom surface of top plate 11.

The panel further includes second electrodes 21 which are used as cathodes. The cathode electrodes 21, which are thin, flat strips, are parallel to each other and are oriented generally vertically, i.e., perpendicular to the upper anodes 13. Each cathode has a plurality of apertures 23 therein and when the panel is assembled the apertures 23 are aligned with the matrix of holes 17 in the insulating plate 15. Each portion of an upper anode 13 aligned with an aperture 17 of plate 15 and that portion of cathode 21 beneath the aperture 17 defines an upper (display) cell of the panel.

Located below the cathode electrodes 21 are third electrodes 25 which are operated as lower or scanning anode electrodes. Located below lower anodes 25 is a lower plate of an hermetic dielectric material such as glass or ceramic 27 which has a plurality of grooves or slots 29 in its top surface. The lower anodes 25 and the grooves 29 are also oriented horizontally, i.e., parallel to anodes 13. Lower anodes 25 are also preferably in the form of wires and, when the display panel is assembled, the lower anodes 25 are seated in the grooves 29 of lower plate 27. Each cathode 21 crosses each lower anode 25 and the crossings are aligned with an aperture 23 and a hole 17. Each crossing together with an aperture 23 of a cathode 21 defines a lower (counting or scanning) cell.

When the panel is assembled an ionizable gas is introduced into all the cells and the panel is sealed at its edges by a nonconductive and gas impervious means such as a fused glass frit. The upper display cells and the lower scanning or counting cells are in communication, i.e., there is a path from each upper cell to the corresponding lower cell through the apertures 23 in the cathodes 21.

In describing the operation of the display panel the array or matrix of holes 17 in insulating plate 15 may be thought of as being arranged in rows and columns. A column, for the purpose of this description, will be taken as a direction parallel to cathode electrodes 21 and a row will be the direction parallel to the anode electrodes 13, 25.

The operation of the display panel will now be described. FIG. 3 is a partial illustration of FIG. 2 including two upper anode electrodes 13*a*, 13*b*, three cathode electrodes 21*a*, 21*b*, 21*c*, and two lower anode electrodes 25*a*, 25*b*. The operation of the multilayer display panel is described in detail in the copending applications of Ogle and Holz, Ser. No. 850,984, filed Aug. 18, 1968, and Ogle and Holz, Ser. No. 828,793, filed May 28, 1969, both assigned to the assignee of the present invention. Reference is made to those applications for a more complete discussion of the operation. Briefly, in one mode of operation of the panel, the lower cells are continuously scanned column by column by the sequential energization of cathodes 21*a*, 21*b*, 21*c*, and simultaneous energization of all the anodes 25*a*, 25*b*, and glow is produced in each column of cells in turn. This sequential scanning of the lower cells is continued at a rate to maintain cathode glow on the lower surfaces of the cathode electrodes 21 around the apertures 23.

Simultaneously with the scanning and synchronously with the scanning rate, information signals are selectively applied to the upper anodes 13*a*, 13*b* and, where the information signals appear, glow is transferred upwardly from the scanning cell into the display cell through the apertures 23 in the cathodes 21. The intensity of glow in the display cell is determined by the level of the information signal. As the panel is scanned and information signals are applied a stationary but changeable display or message is visible through the upper plate 11.

Voltage and current conditions in the scanning cells are adjusted to maintain a low level cathode glow in each scanning cell around aperture 23. As explained in detail in the aforementioned copending applications, this condition is preferably achieved by maintaining the scanning anodes 25 at +250 volts and sequentially energizing each cathode electrode at +100 volts with a scanning pulse at close to ground potential. The electrodes 13 (upper anodes) may have a normal voltage of +130 volts for example, with information pulses of +250 volts.

If the diameter of the apertures 23 is kept quite small, for example, about 3 mils, the voltage differential between the top surface of cathode 21 and the scanning anodes 25 is normally not sufficient to cause cathode glow on the top of the cathode unless an information pulse is present at anode 13. However, it has been found quite expensive to form all these tiny apertures 23 with accurate precision. In addition, there may be small variations in voltage or current conditions. Either variations in aperture diameter or in voltage or current conditions may be sufficient to cause at least some cathode glow in the display cells without an information pulse being present on upper anode 13.

The present invention lies in the discovery that an intermediate layer of cells may be used to prevent glow from reaching the display cells inadvertently. These intermediate layers of cells may be made larger than the upper or lower cells, hence a much greater and therefore a much more unlikely variation in voltage or current condition would have to occur to cause the glow to spread from the intermediate layer of cells into the upper display cells. Thus, the intermediate layer of cells acts as a barrier to prevent the spread of cathode glow to the upper cells unless an information signal is present on the appropriate anode.

Referring now to FIGS. 4 and 5, the new cathode of the present invention which provides an intermediate layer of cells will be explained in the environment of a display panel. Each cathode 21 of the prior art panel (FIGS. 1–3) is replaced by a new cathode 31. Cathode 31 is a double-layered cathode comprising a top cathode layer 33 and a bottom cathode layer 35. The cathode layers, which are thin flat strips, are separated by spacers 37 which may be of a glass frit or other material which is electrically nonconductive and relatively impervious to the ionizable gases which are used. The spacers are in contact with both cathode layers 33, 35 and the region between the layers 33, 35 and adjacent spacers 37 defines each intermediate cell 39. The cathode layers 33, 35 are connected by an electrically conductive member 41 which is external to the region of the matrix of upper, intermediate and lower cells.

Each top cathode 33 has a plurality of apertures 43 therethrough, and each bottom cathode 35 has a plurality of apertures 45 therethrough. These apertures 43, 45 taken together serve the same function as apertures 23 in the old cathode 21. Apertures 43 and 45 are aligned with the matrix of holes 17 in the intermediate insulating plate 15 to provide a communication path between the upper cells and the lower cells. This path is through hole or aperture 43 in the upper cathode 33, through intermediate cell 39 and through aperture 45 in the lower cathode 35. The plurality of intermediate cells 39 comprises an intermediate layer of cells.

When gas in the lower cell is ionized by a potential applied across lower anode 25 and cathode 31 it is possible that the ionization current is sufficient to cause the cathode glow to spread up through aperture 45 in lower cathode layer 35. However, because of the double cathode construction of the present invention, if the glow does spread through aperture 45 in the lower cathode it will be retained in a larger intermediate cell 39. The glow will not spread up through aperture 43 in the upper cathode 33 and into the display cell until the proper information signal is placed on the upper anode 13.

It is apparent that the size, height, and location of the spacers 37 may be changed to provide the appropriate size of intermediate cells based upon the ionization current used and other empirically obtainable data relating to the performance of the display panel. Furthermore the polarity of anodes and cathodes may be reversed by a corresponding change in the voltage from positive to negative. Therefore it should be realized that many modifications are possible without departing from the spirit and scope of my invention.

What is claimed is:

1. In a display device including first and second layers of gas-filled cells with separate first electrodes associated with each layer and a second electrode in common between said layers, wherein individual cells in each layer are interconnected by an aperture of very small diameter, the improvement comprising:

means in common to said first and second layers for providing an intermediate layer of cells in the second electrode for preventing spurious transfer of electrode glow from cells in said first layer to cells in said second layer.

2. The apparatus of claim 1 wherein said providing means includes:

a double-layered electrode, said electrode layers being maintained apart by nonconductive spacers.

3. The apparatus of claim 2 wherein said spacers are a glass frit.

4. A display panel comprising:

an array of first and second communicating gas cells, means for maintaining glow in said first cells, selective means for spreading said glow into said seconds cells, and

electrode means providing intermediate cells for preventing the spread of said glow into said second cells in the absence of activation of said selective means.

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